Rutgers, The State University Of New Jersey Department of Electrical and Computer Engineering 332:546 Wireless Communications Technology

HOMEWORK 5

- 1. Prove for a linear code that the distance structure is the same viewed from any other codeword. That is, for every d, every codeword sees the same N_d other codewords at distance d.
- 2. An uncoded channel needs E_b/N_0 of 2 dB to achieve a BER of 10^{-2} and 10 dB to achieve a BER of 10^{-5} . A rate 1/2 code subject to random bit errors with probability p = 0.01 produces an output BER of 10^{-5} What is the coding gain at 10^{-5} BER? If the coded channel operates at $E_b/N_0 = 5$ dB, what is the uncoded BER?
- 3. A block code has $d_{\min} = 9$. Find the maximum guaranted error detection if maximum error correction is employed. How would this change is only single error patterns are corrected? Find the acheivable error correction if an extra thee bits in error should be detectable.
- 4. Suppose the sequence $x_1, \dots, x_4, 0, 0$, with the x_i iid and equiprobably 0 or 1, is passed through the convolutional encoder in Figure 8.5. At the output of a BPSK receiver with error probability p < 1/2, we observe the hard decision sequence

110 101 111 110 101 001

What is maximum likelihood input x_1, \dots, x_4 ?

- 5. Suppose we modify the convolutional encoder of Figure 8.5 by deleting the output C_1 . Find the extended state diagram and the transfer function T(D, N) for the extended state. Assuming BPSK signaling and soft decision decoding, use the union bound to upper bound the probability P_e of mistaking the all zero sequence for some other sequence. In addition, find an upper bound to P_b , the probability of bit error. Compare your upper bound to the bit error rate of uncoded communication.
- 6. **Final Exam Problem:** Submit one final exam problem and solution. The topic may be any subject we have covered this semester. Your problem must be solveable by a skilled graduate student in 30 minutes. Your grade on this problem will depend on the inventiveness and clarity of your problem and solution. Note that particularly good submissions may motivate actual final exam problems. :)